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Radiochemistry as a ρR Diagnostic with the RAGS Gas Collection System

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Radiochemical diagnostic techniques such as gas-phase capsule debris analysis may prove to be successful methods for establishing the success or failure of ignition experiments at the National Ignition Facility (NIF). Samples in the gas phase offer the most direct method of collection by simply pumping out the large target chamber following a NIF shot. The target capsules will be prepared with dopants which will produce radioactive noble gas isotopes upon activation with neutrons.

We have designed and constructed the Radchem Apparatus for Gas Sampling (RAGS) in order to collect post-shot gaseous samples for NIF capsule diagnostics. The

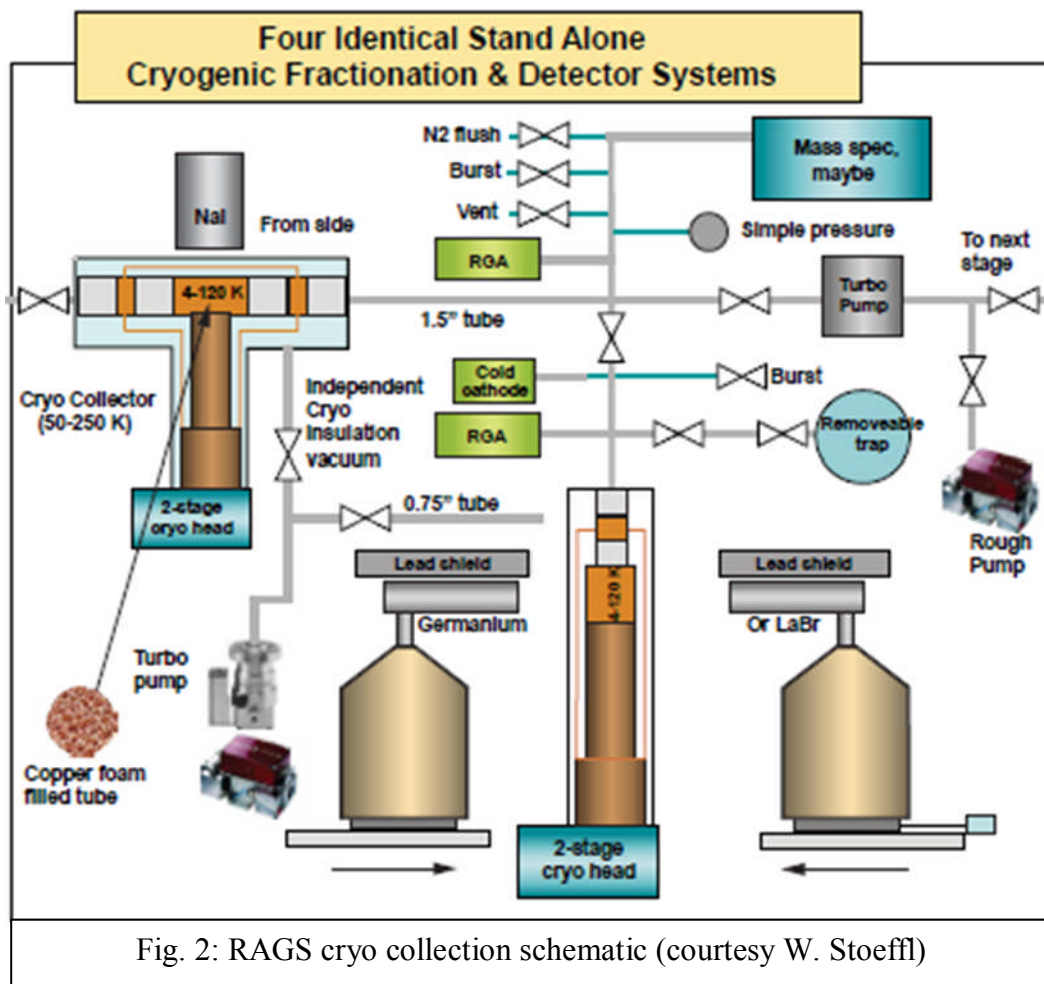


Fig. 1: RAGS pre-cleaner prototype at Lawrence Berkeley National Laboratory.

design of RAGS incorporates multiple stages intended to purify, transfer, and count the radioactive decays from gaseous products synthesized in NIF experiments.

At the moment the dopant of choice is ^{124}Xe , which will undergo (n,γ) and $(n, 2n)$ reactions to produce ^{125}Xe and ^{123}Xe . The half-lives of each are on the order of multiple hours and are suitable for long-term gamma-counting. These isotopes and the rest of the gases evolved in a NIF shot will be drawn through the NIF turbo pumps, past the temporarily shuttered cryo pumps (to aid our collection efficiency), and towards the first main portion of the RAGS system: the pre-cleaner (see Fig. 1).

The pre-cleaner will consist of a water removal system, a series of heated getter cartridges to remove most other impurities such as N_2 , O_2 , CO_2 , etc., and a residual gas analyzer (RGA) to monitor vacuum quality. The noble gases will flow through the pre-cleaner and into the second stage of the system: the cryo collector.



This cryo collector consists of a main cryo head for noble gas collection which will operate for approximately five minutes post-shot. Afterwards a valve will close and isolate the pre-cleaner, while the cryo head warms to release the Xe gas to one of two locations – either a second cryo station for in-situ gamma counting, or to a small cooled gas bottle for removal and counting.

Additional capabilities of the RAGS system include a noble gas calibration apparatus attached to the NIF target chamber, which will be operated hours pre-shot to determine collection efficiency through the whole RAGS system via the signal detected from the RGA. Also it is possible there will be the addition of a helium puff system to drive the Xe through the pre-cleaner and collection stations. (see Fig 2 for more detail) It is also likely that multiple cryo collection stations will be built into the system in the future to fractionate and collect other noble gases such as Kr, Ar, and possibly Ne.

A prototype pre-cleaner has been built at Lawrence Berkeley National Laboratory (LBNL) and is in the testing phases. The information learned in this testing will help collaborators at Sandia National Laboratory that are building and delivering the systems that will be deployed at NIF. The LBNL testing so far has demonstrated that radioactive fission gases can be flowed through the system with and without carrier gases of air and/or He, and the activity can be collected on an activated charcoal sample. Further testing in the upcoming months will hopefully yield more information about any presence of Xe in the water removed from the system, and commissioning of a small cryo cooler as well.

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